FINAL REPORT

GEOSPATIAL INFORMATION SYSTEM (GIS) SUB-PROCESS ACTION TEAM

AUTOMATION/COMMUNICATIONS PROCESS ACTION TEAM

MISSISSIPPI VALLEY DIVISION

NEW ORLEANS DISTRICT

VICKSBURG DISTRICT

MEMPHIS DISTRICT

ST. LOUIS DISTRICT

ROCK ISLAND DISTRICT

ST. PAUL DISTRICT

APRIL 1999

EXECUTIVE SUMMARY

Geospatial data are features or objects that may be positioned on the Earth's surface and the associated attribute information. Pragmatically, geospatial data are common Corps mapping features, e.g., hydrographic and topographic surveys, aerial photography, navigation charts, and land use, wetlands and real estate maps.

A Geospatial Information System (GIS) consists of digital geospatial data along with the computer hardware and software required to generate, store, manage, and manipulate the data.

Geospatial data are an integral part of MVD business processes from project planning to operations. Most products are developed wholly or partly with geospatial data and systems, and many routine tasks, from deciding when and where to dredge the Mississippi River to evaluating wetlands impacts for a feasibility study, are based on these data.

Within MVD about **25 million dollars** are spent annually to collect and manage geospatial data. Moreover, historic geospatial data holdings are extensive and truly priceless. Sizeable capital outlays have been made in GIS hardware, software and training. **The crucial question is "Are these mission-critical data and systems effectively managed to achieve full benefits of the large GIS investment?"**

While GIS is widely used in MVD, the GIS Sub-PAT found that modern geospatial technologies are not effectively employed throughout the organization. Consequently, many potential benefits of the large investment in GIS are not realized. Data are typically contained in "stovepipes", accessible to only a few specialists and not in standard format. Furthermore, no catalog of geospatial data is available for users to determine what is available, how to obtain it, or the data characteristics. Large quantities of irreplaceable historic data are not in digital format, are deteriorating, and are inaccessible. Moreover, there is insufficient software and hardware within the organization to allow efficient access and analysis of GIS data.

Clearly, it will not be possible for MVD to successfully compete as a world class civil engineering organization without automating fundamental work tasks and business processes with a modern GIS. Only with this technology can the complex engineering, economic, and environmental analyses required today be efficiently performed. Just as successful implementation of CADD technology increased efficiency, GIS will lead to a more productive organization. **Effective and efficient collection, management, and utilization of GIS, therefore, must be a corporate goal.**

To meet this goal, the GIS Sub-PAT makes the following summary recommendations. Detailed recommendations are in Section V.

1. Establish in each District & Division a centralized Enterprise Geospatial Information System (GIS) in Tri-Services Spatial Data Standard (TSSDS) format with Oracle as the relational database software. Development of the Enterprise GIS would begin following approval of Implementation Plan.

2. Develop an Implementation Plan, as required by ER 1110-1-8156, by March 31, 2000 in each District & Division for building and managing the Enterprise GIS, putting geospatial data on the desktop, and implementing related GIS initiatives contained in the Recommendations Section. These plans would be subject to approval by the RMB/BOD.

3. Establish (if not already done), empower, and fund the GIS Technical and Oversight Committees required by ER 1110-1-8156 in each District & Division not later than 1 July 1999 to develop Implementation Plans and coordinate the

management and utilization of GIS. The Oversight Committees should be directly accountable to the RMB/BOD for developing and executing Implementation Plans and this effort should be made a CMR indicator.

4. Immediately increase benefits of GIS by deploying low-cost GIS data viewers and web applications on the desktop, training users throughout the organization on GIS, and developing a simple, accessible catalog of existing geospatial data holdings by September 2000.

5. As a routine business practice, require metadata in standard format for all new data and post metadata to the Corps' Clearinghouse web site as required by ER 1110-1-8156.

6. Immediately reconstitute the REEGIS Work Group, established in 1990 with 2-3 members from each District & Division, as the MVD Geospatial Data and Systems Work Group to provide guidance on common technical issues associated with development of the Enterprise GIS.

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I. INTRODUCTION

GEOSPATIAL INFORMATION SYSTEMS PAT SUB-TEAM

The Regional Management Board (RMB) and Board of Directors (BOD) of the Mississippi Valley Division (MVD) established several process action teams (PAT) to study ways and means to improve the function, operation and efficiency of the MVD corporation and business units.

The Automation’s Communication Process Action Team was established to evaluate customer requirements for seamless, timely, and accurate sharing of electronic information within and facilitate sound technical and business procedures consistent with Corps policy. One technical area selected for study by the A/C PAT was Geospatial Information Systems (GIS). A GIS Sub-PAT representing several business areas and with broad GIS experience was formed to accomplish this task (Table 1).

The team's mandate was to recommend management and policy changes to optimize the use of GIS data and technology now and in the future. About $25,000,000 are invested annually in MVD for geospatial data and the vast quantity of historic data are worth much more. Clearly, more effective utilization of this trove of information will increase work efficiency, improve quality and enhance customer service. The challenge is getting the geospatial data needed for mission accomplishment online, in a standard format, and making it readily available to engineers and scientists throughout the organization.

The GIS Sub-PAT was initially tasked to study relational database management systems, GIS to the desktop, and metadata. But it quickly became evident that broader GIS issues had to be considered to properly addressed identified needs. Findings and recommendations presented herein include broad recommendations to improve present and future management and utilization of GIS, as well as specific measures that can be implemented in the short term to increase GIS benefits.

Table 1. GIS Sub-PAT Members

NAME	DISTRICT	ORGANIZATION
Steve Cobb	MVD	CEMVD-PM-R
Dennis Beer	New Orleans	CEMVN-ED-SE
Jay Ratcliff	New Orleans	CEMVN-ED-SE
Rick Cain	New Orleans	CEMVN-IM-I
Richard Miller	Vicksburg	CEMVK-RE-P
Mike Ricketts	St. Louis	CEMVS-CO-F
Phil Brown	St. Louis	CEMVS-CO-F
Kevin Anderson	Rock Island	CEMVR-PM-M
John Kincaid	Rock Island	CEMVR-ED-DM
Keith LeClaire	St. Paul	CEMVP-PPP-P
Dan Wilcox	St. Paul	CEMVP-PPP-P

WHAT ARE GEOSPATIAL DATA AND INFORMATION SYSTEMS?

Geospatial data are not new to the Army Corps of Engineers. Technically, geospatial data are physical features with a position on the Earth's surface and the associated information about these features. Pragmatically, these data are commonly collected and are the foundation for most planning, design, construction, and operational business processes. Hydrographic and topographic surveys, aerial photography, and land use, real estate, habitat, and jurisdictional wetland maps are but a few commonplace examples of geospatial data used everyday by Corps' engineers and scientist. Today most geospatial data are collected and stored in digital format.

Geospatial information systems (GIS) are comprised of geospatial data in specific format and the computer software and hardware required to store, manipulate, conduct analyses, and produce products, like maps, from these data. Typically, a GIS contains digital map data in either ESRI's Arc/Info or Intergraph's MGE format that have been developed for a specific business process or project. These data reside on a server that is operated by ETS, PPM, or IM.

Geospatial data have two components. One, the graphical representation of the data as digital lines (vectors), grids or images, and two, the associated attribute data. Attribute data consist of information about a graphical feature and are stored in a relational database or together with the graphics as an object. Attribute and graphical data are linked, giving the GIS the power to conduct complex spatial and mapping analyses and provide input for decision-making. For example, an elevation contour represented graphically as a line would have the elevation, date and other information about the contour in a linked database record.

ROLE OF GEOSPATIAL DATA IN CORPS BUSINESS PRACTICES

Geospatial data are an integral part of Corps business processes. Hydrographic surveys, for example, are the basis for structure design, delineating aquatic habitats, monitoring navigation channel conditions and channel response to engineering structures, determining dredging locations, and quantities, and assessing long-term trends in river morphology. Aerial photography is used for project planning, mapping, permit evaluations, environmental studies, and in Plans and Specifications.

Think of a GIS as a series of intelligent digital maps. GIS power is not simply displaying the maps, but in the capability to conduct complex spatial analyses to support making decision. GIS maps may be overlain to determine the optimum location for a new road. Or spatial queries can show all critical levee sections that are within 150 feet of a riverbank that is not revetted.

MVD Districts & Division have a long history of using GIS. One example is the Regional Environmental and Engineering Geospatial Information System (REEGIS), a comprehensive GIS of the Mississippi River established in 1990. Extensive environmental and hydrographic GIS data have been assembled for the Upper Mississippi River Navigation Study and Long Term Resource Monitoring Program. And a GIS has been developed for the Louisiana coastal zone, Orleans Parish, the New Madrid Floodway, and many other projects.

Geospatial data are relied upon daily for mission execution, especially system-wide studies. A good example is the use of GIS to evaluate wetlands and habitat impacts of 128 levee work items for the Mississippi River Levees supplemental EIS. Only with GIS could this complex project have been completed in 18 months.

GIS is an effective tool for planners, designers, and managers in all MVD business areas. The ability to display hydrographic data for a navigation channel may be just as important to a senior manager as to a technician, although for different reasons. GIS, therefore, needs to be a tool that is made available to all personnel in the same manner as business applications like email, word processing, CEFMS, and CADD drawings.

GEOSPATIAL DATA AND SYSTEMS REGULATIONS

There are specific guidelines and requirements for the development and management of geospatial data and systems (GD&S) by the Corps of Engineers

(Appendix A). These are contained in the following Executive Order and USACE regulations:

- Executive Order 12906 (11 April 1994), Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure.

- Engineering Regulation ER 1110-1-8156 (1 August 1996), Policies, Guidance, and Requirements for Geospatial Data and Systems.

- Engineering Circular EC 1130-2-206 (1 May 1996), Dissemination of Electronic Geospatial Data on Navigation Projects.

The GD&S regulations direct Districts/Division to establish a Technical Committee, responsible for developing a GD&S Implementation Plan, and an Oversight Committee responsible for ensuring overall compliance with the regulations and that the Implementation Plan is carried out. A Point of Contact for GD&S must also be designated.

The regulations also required that all new geospatial data must be documented with metadata files that are posted to the Corps' centralized Clearinghouse web site. Metadata are simply an abstract of the characteristics of a set of geospatial data, e.g., the date, location, scale, and source of the data. The regulations further direct that all geospatial data be shared with the public and other agencies. In addition, Commands are to enter into cost-shared data development projects, where feasible, in order to reduce Federal expenditures for geospatial data, and are to avoid duplication of data collection efforts through coordination.

Finally, all Commanders are required to sign a statement that is included in the annual Civil Works budget submission certifying that metadata have been posted to the Corps' Clearinghouse web site and that other Clearinghouse sites have been searched prior to acquiring new geospatial data.

II. GEOSPATIAL DATA AND SYSTEM NEEDS

The effective and efficient collection, management, and utilization of GIS must be recognized as a MVD corporate goal. It will not be possible for MVD to be a world class engineering organization without automating fundamental work tasks and business processes with modern geospatial technologies. Just as successful implementation of CADD increased efficiency and production, more effective use of GIS will lead to a more productive and competitive organization.

Why is this so? Because geospatial information is an integral part of Corps most business practices from project planning to project operations. Most classic Corps products, e.g., topographic and hydrographic maps, project reports, and navigation charts, are developed wholly or partly with GIS. Most routine project analyses involve geospatial data, from deciding when and where to dredge the Mississippi River to evaluating impacts of alternatives on wetlands for a feasibility study.

One major GIS need is getting existing geospatial data in digital format. The thousands of historic boring logs and associated geologic maps, for instance, are typically available only in paper format stored in file drawers. Digital ownership maps of all Corps real estate holdings or not in digital format. These linked to REMIS would greatly benefit real estate tasks.

Making GIS readily available to personnel throughout the organization is another major GIS need. GIS must be online and accessible engineers and scientists to be effective. Presently, geospatial data are contained in “stovepipe” databases in a variety of formats, accessible to only a few GIS experts.

There is a great need to make maximum use of existing geospatial data holdings. One major drawback if that personnel simply do not know what geospatial data exists. To exasperate the problem, there is no catalogue of geospatial data holdings for engineers and scientists to easily determine what data are available, how to obtain the data, or the characteristics of the data.

Lack of sufficient software and, to a lesser extent, hardware to effectively use existing GIS is another need. Without adequate computer resources, users cannot expeditiously view or conduct spatial analyses with existing GIS.

There is a vast trove of historic geospatial data in MVD that is truly priceless. Major parts of these holdings, particular historic hydrographic surveys, are deteriorating or being lost. There is a pressing need to archive this valuable data in a GIS.

Training all level of GIS users on software and the characteristics and limitation of geospatial data is essential to realizing the full benefits of GIS. Currently, the level of understanding of GIS is limited to expert “power users” and a few scientists and engineers.

Automation of many standard functions and business practices that are intrinsically spatial or rely heavily on GIS is another major need. Many business areas could be automated with geospatial technologies to increase efficiency, enhance product quality and improve customer service. Some examples are Real Estate, Regulatory Functions, Geotechnical Engineering, Emergency Operations, Survey and Mapping, Levee and Drainage, and Environmental Analysis.

Given the vital role of GIS, it is not surprising that annually in MVD about 25 million dollars are spent to collect and manage geospatial data (Table 2). In addition, sizeable capital outlays have been made for GIS computer hardware, software and training. While GIS is obviously utilized in MVD, instances where this technology is used to its maximum potential to improve performance and quality are few.

Considering the identified needs and problems, it is evident that GIS is not the benefits of GIS are not being realized in MVD. Clearly, the organization is not effectively managing and using this mission-critical technology to maximize benefits of the large GIS investment.

Table 1. MVD Annual Geospatial Data Costs

DISTRICT	ANNUAL COST
New Orleans	$8,000,000.00
Vicksburg	$5,000,000.00
Memphis	$2,500,000.00
St. Louis	$2,500,000.00
Rock Island	$2,000,000.00
St. Paul	$2,500,000.00
MVD	$350,000.00
Total	$22,850,000.00

III. TECHNICAL CONSIDERATIONS

GENERAL

Several actions will be required in order for MVD to realize the full benefits of the GIS investment and meet the GIS needs identified by the GIS Sub-PAT. These actions should be formulated into a comprehensive implementation plan that is institutionalized as a standard business practice. The plan should fulfill present and future needs and be consistent with Corps GD&S objects and regulations and the National Spatial Data Infrastructure initiative (Appendix A).

A wide diversity of geospatial data types and requirements exist and most data can be used in multiple business areas and applications. Hence the plan must be closely coordinated within the organization and fully endorsed by all levels of District/Division management and approved by the RMB/BOD.

ENTERPRISE GEOSPATIAL INFORMATION SYSTEM

A well-designed enterprise geospatial information system that is in a standard format, contains the required compliment of geospatial data, and is readily available to all users will be necessary to realize the potential benefits of the spatial data warehoused at each district. Such a system would be analogous to CEFMS, PRISM, SAACONS, DCPDS, the water control database, and similar corporate databases within the Corps. All geospatial data would be entered into the Enterprise GIS and users throughout the organization would extract data from it for accomplishing tasks.

The Enterprise GIS must be viewed as an investment in the future of MVD. Long-term benefits of an Enterprise GIS will come from the application of GIS to improve routine business practices. As occurred with the deployment of information management tools such as word processors, electronic mail, and internet Web services, and CADD, great benefits are and will continue to accrue from the application of GIS that are above and beyond the mere replacement of existing business practices. The short-term cost of establishing an Enterprise GIS may appear high, but these will be offset through time by the increasing benefits of the Enterprise GIS.

Database Centralization

The Enterprise GIS would be centralized within each District/Division. Data would be stored on a single hardware system (server and associated peripheral devices) where feasible, as opposed to several separate systems operated independently. The exact configuration would depend on local district IM considerations such as network constraints and availability of administrative resources. This configuration would require consolidating GIS data now located in various organizations. While there would be some institutional opposition to centralization, the benefits would far outweigh the drawbacks. These include reduced system administration costs and manpower, improved data quality control, and faster and wider accessibility to geospatial data holdings. Also, critical geospatial data could be more efficiently shared among districts/division offices for system-wide studies, corporate evaluations, and QC/QA activities.

Generally, various branches or divisions would have a working GIS that is a segment of the centralized Enterprise GIS. Most new geospatial data and applications required to complete project work would be developed at this level. When data are finalized, they would be posted to the sharable portion of the Enterprise GIS. Working GIS databases should be housed on the central GIS data server where practical with the number of separate servers kept to minimum. With this configuration, posting data to the sharable Enterprise GIS would be quite simple.

Standard Format

The one ingredient essential for the success of an enterprise GIS is standardization of graphic and attribute data formats. Without a standard data format, many benefits of an Enterprise GIS cannot materialize. This becomes evident if one considers the problems that would arise if different business areas within a district used different data formats for cost accounting data instead of a standardized system, i.e., CEFMS.

In MVD, geospatial standardization has not been universal. The Regional Engineering and Environmental Geospatial Information System (REEGIS) database is the one notable example of using a standard format for a comprehensive geospatial database covering a large project area (Mississippi and Atchafalaya Basins, Madrid Floodway/St. Johns Bayou Basin. On the impounded reaches of the Upper Mississippi River, extensive geospatial data have been developed by other Federal and State agencies, but are not in a standard format. Efforts have been underway to convert some of these data to REEGIS format.

The Corps of Engineers has elected to use the Tri-Service Spatial Data Standards (TSSDS) as stipulated in ER 1110-1-8156. These are being developed by the CEWES-ITL under joint purview of the Army, Navy, and Air Force. The TSSDS contains data structures for a wide variety of geospatial data, but traditionally was oriented towards facilities management for military bases. With the exception of one minor instance, TSSDS have not been implemented within MVD

When MVD began development of REEGIS in 1990, it was necessary to construct a new data structure to accommodate the needs of a civil works navigation and flood control project due to the limitation of the TSSDS in providing these data structures.

In 1998, CEWES-ITL and MVD began incorporation of the REEGIS schema into TSSDS. Thus, the REEGIS

Work Group was actually preparing to convert REEGIS databases into TSSDS format prior to the GIS Sub-PAT study. With the REEGIS features in TSSDS Version 1.8, most needs of Corps navigation and flood control projects will be met.

Standard data formats have numerous advantages. Standardization is highly user-friendly, allowing users to more easily become familiar with the contents of a GIS and to develop applications. Also applications developed in one organization or district can be readily adapted to others. QC of data entry and development is significantly improved by standard formats. In addition, time and costs required for conversion of geospatial data into a common format for specific applications are eliminated.

There are some disadvantages to format standards for geospatial data. Primary is the cost of converting data to the new format. Also, changing data formats that are familiar may be unpopular and can affect short-term performance. Another disadvantage is using data in a different format for another agency or vendor. In this case, a request for the addition of a new data type will have to be made to the Tri-Services CADD/GIS Center. It will require considerable time for approval and incorporation of these change requests into the standard. Also, data acquired from other agencies or vendors may not be in TSSDS format and will have to be converted.

Building the Enterprise GIS

Building an effective Enterprise GIS will involve many considerations. These will include making maximum use of existing investments in GIS data and systems, applying a sound general design, and development of a thorough, pragmatic implementation plan. This effort will have to be closely coordinated within MVD. Financing the Enterprise GIS will require a combination of project and Division-wide resources.

Design Considerations

The enterprise GIS must be designed properly to realize the potential benefits. Design parameters include 1) data structure and format; 2) software; and 3) hardware.

Using the TSSDS for the enterprise GIS will satisfy the data structure and format design consideration.

Implementation of ESRI's ARC/INFO or Intergraph's MGE software for WindowNT will satisfy the requirements for a software platform. Another important consideration will be the effective deployment of GIS data viewers. The relational database management software (RDMS) used to store GIS attribute data should also be standardized.

Hardware and networking configurations will be important considerations. The Enterprise GIS should be centralized on one server/mass storage system. Adequate workstations and PCs will have to be available for users to effectively access the GIS. With increased flow of GIS data across the LAN, faster lines and network hardware will become a necessity.

Management procedures for the Enterprise GIS will have to be developed. These should include internal procedures and data permissions that will allow each organization to post data to the Enterprise GIS and assure that it is sharable by all users. Quality assurance protocols will have to be put in place to assure that all new data are in TSSDS format and are stored in the proper structure and segment of the GIS.

The ultimate design goal for the Enterprise GIS is to implement data warehousing technology. This advancement is very costly at this time, and the software is not yet proven. Tests of one vendor's software at MVD were only partially successful. Additional tests are scheduled in MVR. Nonetheless, as the Enterprise GIS evolves, geospatial data in MGE, Arc/Info, and other vendor formats will be stored in a common data warehouse using Open GIS technology. Various GIS software and data viewers will be able to extract the data, regardless of vendor format, and integrate it seamlessly for analysis. When warehousing becomes feasible, vendor data formats will become less relevant. Currently, ESRI’s Spatial Data Engine and Oracle’s Spatial Data Cartridge are the most advanced warehousing software for geospatial data.

Converting Existing Data

All geospatial data within each organization will need to be converted to the TSSDS and input to the Enterprise GIS. Procedures for converting existing REEGIS MGE data into TSSDS are being developed by WES-ITL. Similar techniques will have to be developed, if feasible, for the efficient conversion of Arc/Info data.

Converting existing data to TSSDS format will be a moderate effort for both MGE and Arc/Info data. Conversion should be done prior to moving data to the centralized Enterprise GIS server. Some data tables may require significant re-formatting and some changes to the TSSDS will be required.

The conversion of MGE data can be accomplished at a relatively low cost. This is because for MGE, graphical data are stored in Microstation design files while attribute data are stored separately in a RDMS like Oracle. Also there are MGE routines for re-formatting both graphical and attribute data. The major issue for MGE databases will be compatibility with the REEGIS features in TSSDS Version 1.8. Since many REEGIS schema changes have been made to accommodate user needs after it was input into TSSDS, this problem would increase the costs of conversion.

Arc/Info graphical and attribute data are typically contained in the same data structure or object. Arc/Info can be configured to use a separate RDMS, but most users rely the Info RDBMS that is included with the software at no extra charge or use Arcview “shape files” which don’t use a separate RDBMS. Conversion of these data to the Enterprise GIS will require that the graphical and attribute data be separated, increasing conversion costs. The new arrangement also will be a major change for Arc/Info users.

It is not possible now to estimate the costs and time that will be required for converting existing data to the Enterprise GIS. These needs will be addressed in the Implementation Plan for each district.

Data Gaps

Filling geospatial data gaps will be the most costly and time- consuming aspect of creating an Enterprise GIS. Once this large initial effort is completed, however, it will only be necessary to input all new data into the Enterprise GIS at a negligible cost. For some business areas, the initial data entry phase will involve digitizing, attributing, and processing significant amounts of historic spatial data. For example, to automate geotechnical tasks with GIS, all historic soil boring locations would have to be digitized and the corresponding information entered into relation database tables linked to the graphic features.

The Implementation Plan (described later) for the Enterprise GIS will contain a detailed assessment of the geospatial data gaps for all organizations in the Districts/Division. Costs and schedules for developing the required data will be presented in the plan. Costs for converting existing data to TSSDS will require analysis of each pertinent data set.

Training

Training on the new Enterprise GIS will be necessary. In-house GIS experts could conduct training at negligible cost. Users need to be educated about the location, applicability, and use of geospatial data. Training on GIS software and basic analysis techniques is also needed. Several training methods can be used. These include periodic short training sessions, GIS Users Groups, and intranet applications for training, assistance with finding data, reporting problems or needs, and posting information about GIS data and techniques. This latter technique can be easily expanded to become a full MVD-oriented process and sharing of information.

The Enterprise GIS will also require advanced users to be informed of changes in data formats, the TSSDS standards, and any steps or changes to processes that are affected by moving data to the Enterprise GIS.

RELATIONAL DATABASE MANAGEMENT SYSTEMS

Standardizing the relational database management system (RDMS) used for GIS is required to maximize benefits of the Enterprise GIS. Presently, Microsoft SQL Server is used for the GIS in MVD, MVK, and MVM and Oracle is employed in the other MVD districts. Oracle is the Corps standard RDMS and is used for all legacy systems, e.g., CEFMS, REMIS, and RAMS. Using Oracle for the Enterprise GIS would enable interfacing with these systems. In addition, the Oracle Spatial Data Object (SDO) is one of the most advanced geospatial data warehousing technologies.

Oracle conversion costs will depend on the number of GIS users and hardware platforms. The estimated cost of additional concurrent user licenses for converting all MVD GIS to Oracle is $162,500.00 (Table 3).

Table 3. Oracle Implementation Costs

DISTRICT	NUMBER USERS LICENSES	TOTAL COST
ST. PAUL	25	$16,250
ROCK ISLAND	50	$32,500

ST. LOUIS	25	$16,250
MEMPHIS	50	$32,500
VICKSBURG	50	$32,500
NEW ORLEANS	25	$16,250
MVD	25	$16,250
TOTAL	250	$162,500

GEOSPATIAL INFORMATION ON THE DESKTOP

At one time or another everyone has asked the question “Where is…?” For instance, project managers ask questions like “Where is the floodwall that impacts my project?”, or, “Where are all the pipelines located which cross the river along the project’s 10 mile stretch?” Currently, it may take days or weeks to answer these “where is” questions, most probably using paper maps generated from CADD or GIS. Since answering geospatial questions is vital to Corps business processes, rapid access to geospatial data for answers is critical. Since geospatial information is a primary ingredient for most Corps decisions, this information must be gotten on the desktop of engineers and scientists as quickly and effectively as possible.

There are three main categories or tiers of District/Division personnel that use or are potential user of GIS. First are the general users that only need access to basic project or district maps and similar general data. This is largest population of users. Next are the intermediate users, consisting of managers, engineers, and scientists that use geospatial data and applications to accomplish routine work tasks. The third and smallest tier of users is the "power users", the GIS technical experts that develop and manage geospatial data and conduct complex spatial analyses.

The power, efficiency, and speed of geospatial information access through Web technology has only begun to be realized and appreciated. Geospatial data can be made readily accessible to all three tiers of users for basic purposes at minimal costs and at an ever-increasing speed via the Internet. Web technology, therefore, is quickly becoming the most effective means to serve geospatial information to the desktop. Web technology can be implemented as the broadest and most far-reaching medium for accessing geospatial data. Both public and in-house personnel can have immediate access to geospatial data using web browsers and free plug-ins. Web browsers can function as the reading tool for everyone.

Geospatial data viewer software and customized web applications are needed for the second tier of GIS users. Geospatial viewers such as ARC/View and GeoMedia are robust tools for accessing and conducting basic spatial analyses and mapping tasks. These “viewers” provide a simply a more effective streamlined view of geospatial data than the mainstream GIS tools. They are more powerful than the normal Web browser tools, but do not have full spatial query capabilities. Web applications, including GeoWeb Map and Active Server Page (ASP) scripts can provide immediate access to the Enterprise GIS. Together ASP and web browser technology can provide reading and viewing of geospatial data as well as limited update capabilities.

The third tier of "power users" requires full-scale GIS technology to accomplish their work. These users develop geospatial data, manage the Enterprise GIS and conduct sophisticated spatial analyses and map production work.

The large amount of geospatial data acquired is captured by different organizations within the Districts/Division. Thus, Real Estate Division captures and maintains ownership and tracts maps, township and range maps, and Corps easements and ROW maps. Operations Division has dredging data, hydrographic surveys, permits maps, and wetland maps. Engineering Division collects and maintains river stage data, and maps of floodwalls, levees, dikes, and revetments. Planning, Projects, and Programs Management Division and Engineering Division may maintain land cover maps for a specific project. Of course there is always overlap and redundancy among these data sets. It is easy to see, therefore, how users in one organization may unaware of geospatial data existing or scheduled to be acquired by others.

To use the Enterprise GIS, individuals throughout the organization must be able to easily determine what data are available, how to access and use it, and the data characteristics. A question constantly asked by all Corps personnel is "Do we have that data and, if so, where is it?" Many Districts have begun to use Web technology to fulfill this need. The methods vary from simple data lists, look up tables, to sophisticated graphics interfaces (refer to Metadata Section).

ER 1110-1-8156 and EC 1130-2-206 mandate the Corps to provide public access to geospatial data. Districts have begun to follow these mandates by seizing and implementing the powerful and effective capabilities of Internet technology. Many other Federal agencies and numerous public and private organizations need and use Corp of Engineers' geospatial information as a fundamental component in performing their own missions. The Corps, in turn, needs geospatial data collected by other agencies, both public and private. By working together we can meet each others geospatial data needs cooperatively, economically, and effectively. Use of the Internet/Intranet technology can be a major factor in this effort.

METADATA

Overview

Metadata is documentation for geospatial data files and is very valuable to the Enterprise GIS. Too often knowledge about the “where and how” of a data set is only in the memory of a particular person or available as hand-written notes. Knowledge about the development and usability of data too often disappears when a key person leaves the organization. A catalog of GIS metadata as well as FDGC-compliant metadata files can significantly increase the long-term benefits of the GIS investment.

Metadata recommendations are geared toward the meeting of internal needs first, enhancing the fulfillment of formal metadata requirements.

Requirements

District/Division Needs

The immediate need for metadata is a simple and easy-to-use catalog of all existing geospatial data holdings. At a minimum, metadata files should contain the data type and source, creator, coordinate system, map projection, mapping accuracy, file format, location, and mapping scale. The catalog should facilitate the determination of what data are available and the data characteristics. Procedures are needed to routinely enter metdata into the catalog, but in a form that can be modified into FGDC-compliant format.

The metadata catalog could consist of simple metadata form implemented as either a MS Word document template, MS Excel spreadsheet, MS Access database, or as an intranet web form. Data entry on the form could be automated with a Visual Basic interface.

The goal of these strategies is again to simplify the process of developing metadata, documentation about of geospatial data holdings, while at the same time encouraging the development of metadata.

Mandatory Requirements

Development of FGDC-compliant metadata and posting these to the USACE Clearinghouse web site are required for all geospatial data by ER 1110-1-8156. The GD&S POC ensures metadata are in the required format and provided to the Clearinghouse.

A significant "hurdle" for developing FDGC-compliant metadata, is the complexity of the content standards. Mandatory metadata elements are limited to a data abstract (thematic and geographic keywords and author). Optional elements include data accuracy, coordinate system, methods of data encoding, and several data attributes. In many respects, the optional elements are the most pertinent and valuable to users. Mandatory elements can be documented in under an hour. Full documentation for a data set, however, can take several hours to complete.

The Corps has software (CorpsMet95) for development of FGDC-compliant metadata. Considerable practice and training is necessary to expediently produce complete usable metadata.

Metadata files for collections of geospatial data, e.g., hydrographic surveys of the Mississippi River, is another option. This approach could decrease the amount of effort required to develop metdata. The Clearinghouse web site already has metadata collections for MVD: Navigation Charts/Hydrography; Topographic; Geodetic Control; Aerial Photographs; Digital Imagery; Habitat; Hydraulics and Hydrology; Coastal; Geotechnical/Geology; Cadastral; and Regulatory Data. If these are kept updated, much of the metadata work has been done.

GD&S Technical and Oversight Committees and Point of Contact

The GD&S Technical Committees in each District should have as a specific agenda item for each meeting a review of all GD&S related activities in the District, including announcing all data collection efforts underway or planned. The Technical Committee, therefore, can be the first step for coordination of all internal District data collection efforts. The type and level of required GIS training should also be determined by the Technical Committee.

The District's GD&S POC needs to be kept apprised of all geospatial data collection efforts in the District. This District POC can in turn, possibly with monthly or bimonthly teleconferences, relay information to other GD&S POCs in MVD and allow for the possibility of cross-District data coordination within the Mississippi Valley.

The District GD&S POC should be given the responsibilities for coordinating geospatial data development with other Federal, State, and local agencies. The GD&S POC should advise project mangers on partnering opportunities for GIS data development.

IV. IMPLEMENTATION

GD&S REGULATIONS

The recommendations presented herein can be readily and effectively implemented within the framework for managing GIS outlined in the GD&S regulations (mainly ER 1110-1-8856). No new management measures or business processes would need to be developed. By incorporating the measures specified in the GD&S regulations as a standard business practice throughout MVD, the goals and recommendations contained herein can be effectively put into practice.

IMPLEMENTATION PLAN

A plan for implementing the recommendations contained herein should be prepared for each MVD District/Division. This plan should contain the following information:

1) Detailed design of the enterprise GIS;

2) Procedures for the systematic processing of data into the enterprise GIS from organizations throughout the district/division;

3) Procedures for system and data management of the enterprise GIS;

4) Specific geospatial data gaps by organization or business;

5) A schedule, cost, general scope of work, and priority for filling identified data gaps;

6) Specific custom applications required for automating individual tasks and production of products involving geospatial data;

7) Proposed hardware configuration for the Enterprise GIS;

8) Cost of required software and hardware for implementing the centralized Enterprise GIS

9) Specific plans, software requirements and costs for distributing data from the Enterprise GIS to the desktop throughout the organization.

10) Procedures for the systematic development and utilization of geospatial metadata;

11) Geospatial technology training requirements and costs

The GD&S Technical Committee of each District/Division should prepare the Implementation Plan. This process should be closely coordinated with all geospatial data users throughout the organization. The plan should contain measures and procedures that are tailored to specifically identified corporate needs, not generalizations. Schedules, costs, and priorities should be an integral part of the plan. The membership of the Technical Committee should be comprised of individuals familiar with geospatial data technologies from all business areas that have geospatial data needs. The Committee should also work closely with users to identify institutional, technical, and funding problems that are hindering or preventing the use of geospatial technologies within the organization.

ROLE OF GD&S COMMITTES

The GD&S Technical Committees in each District should have as a specific agenda item for each meeting a review of all GD&S related activities in the District, including announcing all data collection efforts underway or planned. The Technical Committee, therefore, can be the first step for coordination of all internal District data collection efforts. The Technical Committee would be responsible for assuring that everyone is aware of ongoing and planned data collection work. Web applications are the best way to accomplish this goal.

The GD&S Oversight Committee, made up of senior managers, should be responsible for monitoring the progress and work of the Technical Committee and insure that the Implementation Plan is developed and implemented on schedule. In addition, the Oversight Committee in each district should be directly accountable to the Regional Management Board/Board of Directors for executing the measures recommended in Implementation Plans. Since geospatial data are viewed as a significant corporate resource, emphasis should be placed on successful management and utilization of this resource from top management.

The District GD&S POC should coordinate District GIS work with other Federal, State, and local agencies, and would represent the Corps at regional- or state-level GIS meetings and workshops. The POC would also serve as an advisor on the use, applicability, and development of GIS data to project delivery teams and others.

Users and developers of geospatial data must be informed as to the location, applicability, and characteristics of geospatial data holding. Obviously the more active GIS users should be educated as to the use of the Clearinghouse servers provided by the Federal agencies. Again the GD&S Technical Committee and its members can serve as a focal point for this activity. The District GD&S Implementation Plan can further prescribe specific standard operating procedures to ensure the use of the Clearinghouse nodes. A "GIS Users Group" could also be established to bring together the more frequent users of geospatial data for exchanging ideas, developing "standard" procedures or techniques for analyses and mapping and developing ways to more effectively use GIS.

V. RECOMMENDATIONS

In order to more efficiently and effectively manage and utilize the MVD investment of over $25,000,00 annually in geospatial data and to automate routine business practices using GIS, the GIS sub-PAT recommends the following actions:

ENTERPRISE GIS

1. Establish in each MVD District/Division a centralized Enterprise Geospatial Information System (GIS) in Tri-Services Spatial Data Standard (TSSDS) format with Oracle as the relational database software.

The Enterprise GIS would be the backbone of the geospatial data automation initiative. Development of the Enterprise GIS would begin following approval by the RMB/BOD of Implementation Plans prepared by the GIS Technical Committees in each District/Division. Detailed requirements of each organization will have to be identified and costs and schedules prepared. Existing data holdings would be converted to TSSDS format and data gaps would be filled to populate the Enterprise GIS. District/Division-wide coverage for many basic types of geospatial data, e.g., for roads, streets and street names, rivers and streams, building structures, and political boundaries, and even Corps structures such as locks and dams, are commercially available (see www.mapquest.com and www.zip2.com) or are free.

GIS TO THE DESKTOP

2. Implement in each MVD District & Division a multi-tiered approach to deploying geospatial data on the desktop of users throughout the organization. Immediately increase the benefits of existing geospatial data holdings and technology by deploying free and low-cost geospatial data viewer software (Geomedia, ArcView) on the desktop by September 2000 at an estimated cost of $25,000 to $35,000 per

district. For distribution of geospatial data to the mass of users in the organization, Internet web applications should be developed or acquired as soon as possible. Lastly, for the GIS “power users”, those responsible for creating, processing, and managing the data and conducting sophisticated spatial analyses and mapping functions, full-scale GIS software such as Intergraph’s MGE and ERSI’s Arc/Info should be made available on the desktop.

Purchase an MVD-wide license agreement for software that interactively creates digital maps on the Internet. Specific existing examples can be found at the US Census Bureau web site: www.census.gov.

Use the Internet/Intranet to the fullest extent possible for geospatial data access. Wherever feasible, implement web server technology and tools such as Active Server Pages, Java scripts, Java applets, and Visual Basic scripts and programs. Require each District to be cognizant of security issues pertinent to each data layer with either Internet and/or Intranet access.

3. Provide training on geospatial data software, data characteristics and applications, and quality control issues to major users of geospatial data in the Districts & Division.

Minimum requirements should include training on geospatial data viewers and web technologies and the NGDC data sources. Specific individuals from each organization (Engineering, Operations, Real Estate, etc.) should be identified for training. Individuals serving on the GD&S Technical committees should form the initial list of personnel. Other requirements should include training on the specific geospatial data viewers that are implemented. The GD&S Implementation Plan would contain training goals, schedules and costs. Quality control issues in the use of geospatial information must also be addressed. Training on fundamental topics such as map scales, national map accuracy standards, and specific Corps of Engineer mapping standards should be required by degree as appropriate to the geospatial data user.

METADATA

4. The MVD Districts/Division should provide time and funds to GD&S Points of Contact for training on preparing metadata files using CorpsMet95 or similar tools, maintain metadata documents, and participate in Division and District GD&S coordination meetings.

Unless GD&S responsibilities are given priority, and a means provided to pay for that time, they will otherwise be relegated to a “when I get time” category and not get done.

5. The MVD Districts & Division should develop internal procedures for developing metadata and include them in the GIS Implementation Plan. These should include:

Development of a simple and easy to use catalog of metadata (utilizing Word, Excel, or Access) for geospatial data holdings and simple metadata documentation tools. Standard formats and metadata tools should be developed, if possible.

Development of standard “boilerplate” specifications for metadata development and submission to be used in all geospatial data contracts.

Development procedures for the movement of metadata files from the creating office to the GD&S POC for posting to the Clearinghouse Web Site and entering into the metadata catalog. Maximum use of the Intranet should be made for metadata sharing within MVD. 13.

IMPLEMENTATION

6. To implement recommendations 1-7, the GD&S Technical Committee and the GD&S Oversight Committee should be established in each District & Division not later than 1 July 1999 and

function routinely as a standard business process in MVD.

The Technical Committee should meet regularly (monthly) and coordinate all geospatial development efforts within the organization with approval by the Oversight Committee.

7. A detailed GD&S Implementation Plan for each District/Division should be developed by the Technical Committee under the auspices of the Oversight Committee not later than March 31, 2000.

The plan should identify specific geospatial data needs for each element within the District/Division and include cost estimates and schedules for building the enterprise GIS, converting existing data, and developing digital data to fill data gaps and applications needs. If a GD&S Implementation Plan has been developed, it should be revised to reflect these requirements. The Implementation Plans would be approved by the RMB/BOD prior to initiation development of the Enterprise GIS.

8. The GD&S Oversight Committee in each district/division office will be directly accountable to the MVD RMB/BOD for executing the GD&S Implementation Plan. Execution of the Plan should be made a CMR indicator.

9. Re-constitute the existing REEGIS Work Group into a Geospatial Data and Systems Work Group to provide technical oversight and advice on development of the Enterprise GIS.

The REEGIS Work Group has been operational since 1990 and consists of 2-3 member from each MVD District and the Division. The main tasks of the Geospatial Data Work Group would be solving technical issues regarding conversion of existing data to the TSSDS format, implementing Oracle, and design of the Enterprise GIS.

APPENDIX A: GEOSPATIAL DATA AND SYSTEMS REGULATIONS

EXECUTIVE ORDER EO 12906

This executive order contains the following directives that are applicable to all Federal agencies, including the Corps of Engineers:

1. Establish the Federal Geographic Data Committee, with representatives appointed from all Federal agencies (including USACE) to develop the specific standards regarding geospatial data creation, documentation, and distribution standards. This committee is in place, complete with working groups and standards groups.

2. Create a "Clearinghouse Node", a central Internet Web server for housing and distributing metadata (documentation about geospatial data holdings) to the Public and other Agencies. The USACE Clearinghouse node is http://corpsgeo1.usace.army.mil/, located at CRREL, which is part of the network of Agency Clearinghouses.

3. Document their geospatial data holdings following the metadata document content standards as specified by the FGDC. Current standard is CSDGM Version 2 – 1998.

4. Adopt a plan of procedures for making geospatial data available to the public, using Clearinghouse nodes and other mechanisms. USACE already has procedures to install metadata and geospatial data onto their Clearinghouse node.

5. Adopt internal procedures to ensure that agencies access the Geospatial Clearinghouse before it expends Federal funds to collect or produce new geospatial data, to determine whether the information has already been collected by others, and whether cooperative efforts to obtain data are possible. ER 1110-

1-8156 provides specific USACE guidance for this requirement.

ENGINEERING REGULATION ER 1110-1-8156

The USACE developed this ER to implement the requirements of EO 12906. The basic requirements of this ER for all Commands are:

1. Directs all USACE Commanders, starting with the FY97 Civil Works budget cycle, to certify that their Command has accessed the Clearinghouse, contributed metadata to the Clearinghouse, determined via the Clearinghouse that needed geospatial data are not available from an existing source, that possible data collections partnerships have been explored (para. 7.d).

2. Directs that USACE Commands will establish and maintain two committees, (1) a GD&S Technical Committee to meet at least quarterly and be comprised of persons responsible for geospatial data management, for the function of addressing the technical aspects of compliance with this regulation as well as for coordination; and (2) a GD&S Oversight Committee to meet at least twice annually and be comprised of chiefs of any division or office within the Command that has an interest in geospatial data, for the function of addressing local funding and policy issues related to compliance with this regulation (para. 7.e).

3. Directs each Command (districts, labs) to appoint a GD&S Point of Contact to act as a liaison between the command and HQUSACE, and be responsible for disseminating information related to GD&S through their Command's geospatial data community. The POC will be a member of the Technical Committee and an advisor to the Policy Committee. The POC will review and oversee the distribution metadata to the USACE clearinghouse (para. 7.d).

4. Directs the Technical Committee at each Command to develop a GD&S Implementation Plan that addresses the technical aspects of how the

requirements will be met, that this plan will be reviewed annually, and updated as necessary (not to exceed every three (3) years) to reflect changes. The Implementation Plan will be approved and implemented through direction of the Oversight Committee (para. 7.e)

5. Directs each Command to maintain five responsibilities related to geospatial data and the Clearinghouse, which are overseen by the GD&S POC and committees, as well as certified annually by the commander through the budget certification. These specific responsibilities are:

6. Document new geospatial data using the FGDC Content Standard for Digital Geospatial Metadata. This applies to all data produced or collected since January1995 (para. 7.g(1)).

7. Document existing geospatial data to the extent practicable. The USACE Clearinghouse has handled much of this in a general sense through the development of “collection” metadata that address the major themes of geospatial data historically collected by the Corps (para. 7.g(2)).

8. Submit metadata to the Clearinghouse (para. 7.g.(3)).

9. Utilize the Clearinghouse. Prior to the collection or production of new geospatial data, Commands will access the Clearinghouse to determine whether the data or a usable substitute has already been collect, and if so to then utilize the pre-existing data (para. 7.g(4)).

10. Provide public access to geospatial data. Commands are to develop internal procedures to ensure that their geospatial data is available to the public upon request (para. 7.g(5)).

11. Directs each Command to execute the requirements of EO 12906 within their own budgets, as OMB will provide no additional

funds. Beginning in FY97, project engineers should incorporate any substantial costs associated with compliance into the mapping and database portions of civil works project budgets (para. 8).

ENGINEERING CIRCULAR EC 1130-2-206

This EC contains specific directives applicable to all USACE Commands regarding geospatial for navigation projects. The main requirements are as follows:

1. That all digital mapping, charting, and related GIS data be made available to the public and private users through the USACE node on the National Geospatial Data Clearinghouse (para. 5.a)

2. That no user access fees be charged for any geospatial data downloaded from the USACE Clearinghouse or any other Internet servers maintained by the Corps (para. 5.b).

3. That digital data contained in current inland waterway charts is placed on the USACE Clearinghouse node for public use (para. 5.c).

4. That metadata describing the content and format of geospatial data must be placed on the server along with the geographic data file(s) (para. 5.e).

5. That USACE Commands should not develop electronic charting systems (ECS), and that instead private vendors are encouraged to use USACE geospatial data to prepare these charts. USACE data will be provided free of charge via the USACE node (para 5.f).

6. That current hard copy map or chart products shall continue to be published and disseminated in accordance with Chapter 2 of ER 1130-2-520, Aids to Navigation, Navigation Charts, and Related Data (Draft) (para. 5.g).

7. That Tri-Service CADD/GIS Technology Center Standards will be followed for geospatial data covered in this Circular. The Tri-Service GIS Spatial Data Standard (TSSDS) in particular is applicable to this requirement, and will apply, upon completion of the standard, to the generation of maps, charts, CADD, GIS, and other digital data provided to the general public as applicable by this Circular (para. 5.h).

SUPPORTING DOCUMENTS AND OTHER REQUIREMENTS.

The following documents provide specific techniques, methodologies, strategies, and guidance for compliance with the above requirements and for the use and application of GD&S:

1. Engineer Manual EM 1110-1-2909 (1 August 1996), Geospatial Data and Systems.

2. FIPS 173, Spatial Data Transfer Standards, 1992.

3. Guidelines for Implementing the National Geospatial Data Clearinghouse (8 June 1994), Federal Geographic Data Committee.

4. FGDC-STD-001-1998, Content Standards for Digital Geospatial Metadata (CSDGM Version 2 – 1998)

5. FGDC, Content Standards for Digital Geospatial Metadata Workbook, Workbook Version 1.0 (Describes the June 8, 1994 version of the metadata standard)

6. Tri-Service CADD/GIS Technology Center, Tri-Service Spatial Data Standards (TSSDS), version 1.75 (current version, released January 1999; version 1.8 in beta).

7. CorpsMet95, a Microsoft Windows NT/95/98-based computer program that can be used to edit and create the metadata documents in a format compatible with the designated FGDC Content

Standards. Current version of CorpsMet95 adheres to Version 1 of the CSDGM, adopted June 8, 1994.